

OTAY WATERSHED POLLUTANT LOADING TOOL: Development and Application

Prepared by

AQUA TERRA Consultants
2685 Marine Way, Suite 1314
Mountain View, CA 94043

Submitted to

Aspen Environmental Group
30423 Canwood Street, Suite 215
Agoura Hills, CA 91301

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SECTION 1.0

INTRODUCTION

1.1 BACKGROUND

AQUA TERRA Consultants (ATC) utilized PLOAD, a GIS-based tool within the EPA BASINS model (EPA, 2001a), to estimate annual loads for a list of user-specified pollutants within each subbasin in the Otay River Watershed. The model calculates annual nonpoint loads using the EPA's Simple Method approach,¹ which employs runoff coefficients and event mean concentrations (EMCs) to calculate the annual loads (EPA, 2001b). Point sources and best management practices (BMPs), which can reduce nonpoint and/or point source loads in a specified area, may optionally be included in the analysis. The basic model output includes the area and load for each land use within each subbasin, along with subbasin total loads and annual mean concentrations.

Due to a limitation in the PLOAD implementation within BASINS, that requires the use of a single value for precipitation in all subbasins, AQUA TERRA programmed the PLOAD calculations within an Excel spreadsheet to allow the precipitation to vary by subbasin throughout the watershed. We refer to this spreadsheet as the Otay Watershed Pollutant Loading (OWPL) Tool.

1.2 THIS REPORT

This report describes the development of the OWPL Tool, the equations that perform the loading calculations, the data used to describe the Otay Watershed, and the initial results of the OWPL Tool calculations for the selected constituents. This report is a Final Review Draft subject to review by the WMP Project Team and San Diego County. The current version of the OWPL Tool spreadsheet includes the capability to represent BMPs applied to the watershed; those capabilities will be used to assess and evaluate selected BMP implementation scenarios, as part of the remaining efforts under Task 3 to develop the Otay River WMP.

¹ The Simple Method is an empirical approach developed for estimating pollutant export from urban development sites. The Simple Method has been endorsed by EPA as a viable screening tool for NPDES stormwater projects.

SECTION 2.0

MODELING METHODOLOGY FOR LOADING CALCULATION

PLOAD allows the user to choose between two methods for calculating nonpoint pollutant loads: the Export Coefficient Method or the Simple Method. Despite its name, the latter method actually requires more detailed input and uses a more complicated algorithm than the former. The Simple Method was chosen for the OWPL Tool because most of the required input data was deemed to be available. The remedial effects of BMPs on nonpoint source loading are based upon their removal efficiencies and area of influence. Point source loadings are taken directly from a user-specified table that explicitly lists the annual loading rate for each constituent. Descriptions of the equations used to calculate pollutant loads are provided in this section.

2.1 EXPORT COEFFICIENT AND SIMPLE METHODS

The Export Coefficient Method calculates the loads for each specified pollutant type by subbasin using the following equation:

$$L_P = \sum_U (L_{PU} * A_U) \quad (1)$$

Where: L_P = Pollutant load, lbs/yr

L_{PU} = Pollutant loading rate for land use type u, lbs/acre/year;

A_U = Area of land use type u, acres

Pollutant loading rates must be defined by the user for each land use and each pollutant. Annual loads are simply the product of the loading rate and the land area for each land use.

The Simple Method, implemented in the OWPL Tool, requires two equations in order to calculate the loads for each specified pollutant type; one equation is used to calculate the runoff coefficient so that a runoff volume is determined, and then the an event mean concentration (EMC) for each pollutant and land use is used to determine the annual load associated with that runoff .

First, the runoff coefficient for each land use type is derived with the following equation:

$$R_{VU} = 0.05 + (0.009 * I_U) \quad (2)$$

Where: R_{VU} = Runoff coefficient for land use type u, inches_{runoff}/inches_{rain}

I_U = Percent imperviousness

Then, the pollutant loads are calculated with the following equation:

$$L_P = \sum_U (P * P_J * R_{VU} * C_U * A_U * 2.72 / 12) \quad (3)$$

Where: L_P = Pollutant load, lbs/yr

P = Precipitation, inches/year



P_J = Ratio of storms producing runoff (default = 0.9)

R_{VU} = Runoff coefficient for land use type u, inches_{run}/inches_{rain}

C_u = Event mean concentration for land use type u, milligrams/liter

A_u = Area of land use type u, acres

2.72 = conversion from [mg/L] to [lb/ac-ft] for pollutant concentration

12 = conversion from [in] to [ft] for precipitation

Pollutant loading rates for each constituent and land use are then calculated by OWPL and PLOAD by dividing the annual load by the land use area for each subbasin.

2.2 BMP COMPUTATIONS

In PLOAD, after the raw pollutant loads are calculated using either the Export Coefficient or Simple Methods, three equations are used to calculate the remedial effects of BMPs (if they are included in the analysis) on those loads:

First, the percentage of the subbasins area serviced by BMPs is determined using the following equation:

$$\%AS_{BMP} = (AS_{BMP}/A_B) \times 100 \quad (4)$$

Where:

$\%AS_{BMP}$ = Percent area serviced by the BMP

AS_{BMP} = Area serviced by the BMP, acres (input by user)

A_B = Area of subbasin, acres

Next, the pollutant loads for each BMP are calculated:

$$L_{BMP} = (L_P * (\%AS_{BMP})/100) * (1 - \%EFF_{BMP}/100) \quad (5)$$

Where:

L_{BMP} = BMP load, lbs/yr

L_P = Raw subbasin load, lbs/yr (i.e. without BMPs)

$\%EFF$ = Percent load reduction of BMP

The raw subbasin pollutant loads are derived from the results of the Export Coefficient or Simple Methods, while the percent load reduction comes from the BMP efficiency tables.

Finally, the total pollutant loads accounting for BMPs are computed by subbasin. Each subbasin load is a cumulative total of areas that are and are *not* influenced by BMPs.

$$L = (\sum_{BMP} (L_{BMP})) + L_P * (A_B - (\sum_{AS} (AS_{BMP}))) / A_B \quad (6)$$

In the OWPL Tool, the same calculations are performed for each land use, with the user supplying the areas of each land use within each subbasin serviced by a BMP (i.e. AS_{BMP}), and the BMP removal efficiency for each pollutant (i.e. $\%EFF$). The Tool currently allows up to 10 different BMPs to be defined and used in the calculations.

SECTION 3.0

OTAY WATERSHED INPUT DATA AND CHARACTERIZATION

PLOAD employs ArcView to digitally overlay the subbasin and land use coverages in order to calculate the contributing area for each land use within each subbasin. The additional required numeric data are provided in tabular form via Excel (e.g. % impervious, EMCs, point sources, BMP removal efficiencies) or as a single datum via the user interface (precipitation, ratio of storms producing runoff). The OWPL Tool requires the same input data entirely in a tabular, i.e. spreadsheet, format. GIS processing is done separately and the resulting data is also provided in to the OWPL Tool as an input spreadsheet. In this section we describe the input data required, followed by the specific values and data sources used for the Otay Watershed.

3.1 MODEL INPUT REQUIREMENTS

PLOAD requires both GIS coverages and numeric data as input to the model, as summarized in the following lists:

- 1) GIS Coverages
 - a) Delineated subwatersheds
 - b) Land use distribution
- 2) Numeric Data (based on execution of Simple Method)
 - a) Event Mean Concentrations (EMCs) **by** land use for each constituent, mg/L (bacterial constituents, organisms/100 mL)
 - b) % impervious for each land use
 - c) average annual precipitation, in/yr
 - d) ratio of storms producing runoff (default = 0.9)
- 3) Supplemental/Optional – (depending on scenarios evaluated)
 - a) Best Management Practices (BMPs)
 - i) Table with removal efficiencies for each constituent
 - ii) GIS coverage (point or polygon) of application area
 - b) Point Sources
 - i) Table with quantity of each constituent input to stream, lbs/yr
 - ii) GIS coverage (point) of point source locations

The OWPL Tool requires the same input data as PLOAD, but all the GIS coverages must be preprocessed by the user, and provided in separate spreadsheets within the Tool. Thus, the land use categories and areas, the BMP services areas by land use category, and the point source loads and locations are all provided in separately designated spreadsheets within the Tool.

3.2 INPUT DATA AND SOURCES



3.2.1 Subbasin Coverage

For planning purposes, the San Diego Association of Governments (SANDAG) has divided the Otay Watershed into eight hydrologic subareas (HSAs) ranging in size from 815 to 31992 acres; Figure 3.1 shows the subbasin delineation and Table 3.1 provides the land areas, along with the precipitation ranges for the HSAs. Traveling easterly upstream from the Otay River outlet, the HSAs are Otay Valley, Proctor, Savage, Hollenbeck, Jamul, Lee, Engineer Springs, and Lyon. The GIS coverage for these subbasins was mapped by the California Department of Forestry under specifications provided by the California Department of Water Resources (http://www.sandag.cog.ca.us/resources/maps_and_gis/gis_downloads/downloads/metadata/hydrobdoc.htm).

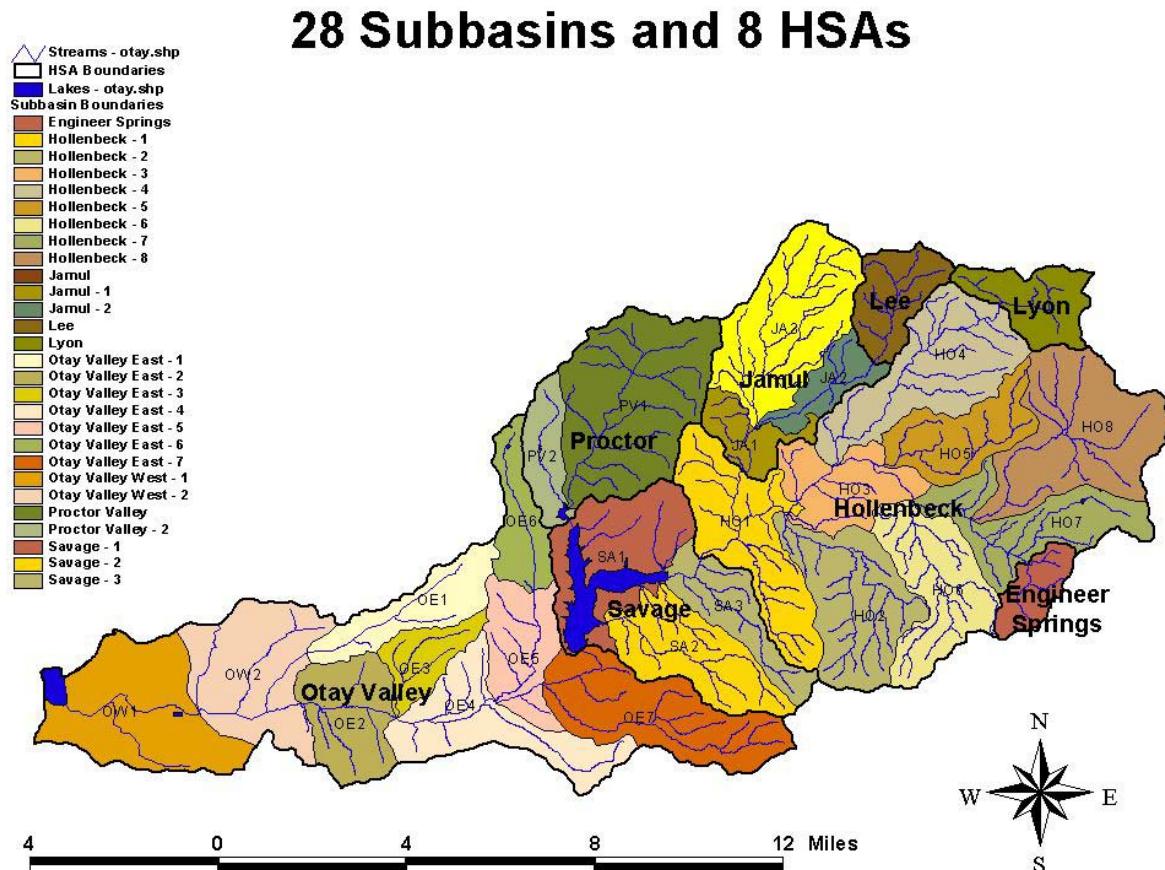


Figure 3.1 Otay Watershed Subbasin Delineation

Table 3.1 Land Areas and Precipitation for the 8 HSA Subbasins

HSA Subbasin	Area (ac)	Mean (in)	Min (in)	Max (in)
Otay West	9781	10.08	9.62	10.76
Otay East	19970	11.58	10.19	16.67
Proctor	7743	12.82	11.37	15.84
Savage	10189	13.12	11.01	18.26
Hollenbeck	31992	14.35	11.21	19.38
Jamul	7947	12.61	11.59	14.21
Lee	2445	15.05	12.97	16.26
Engineer Springs	815	11.70	11.46	11.95
Lyon	2038	17.67	16.48	19.29
Overall Watershed:	92921	12.96	9.62	19.38

For this pollutant loading assessment, the Otay Watershed was further subdivided into a total of 28 planning unit subbasins ranging in size from 815 to 6725 acres; these areas are shown in Table 3.2, along with the precipitation ranges. This further subdivision was based on a previous delineation performed by the Engineer Research and Development Center (ERDC) of the U.S. Army Corps of Engineers. The ERDC coverage resulted in 212 subbasins and was developed for a more detailed spatial assessment and was based on an initial field reconnaissance, aerial photos, and topographic maps (Smith, 2004). The 28 ATC planning unit subbasins were generally aggregated from the 212 ERDC subbasins, but the boundaries do not correspond in all cases. The ERDC boundaries were overlain with a 10-meter resolution digital elevation model (DEM) and it was discovered that those boundaries failed to follow prominent ridge lines in several instances. Those boundary lines were subsequently adjusted based on the topography information from the DEM. Additionally, Otay Valley was divided into eastern and western segments along the hydrologic boundary closest to Interstate 5. The delineation and nomenclature assigned to the subbasins is also displayed in Figure 3.1.

3.2.2 Precipitation

A GIS grid layer of precipitation in the watershed was provided by Joel Michaelsen in the Department of Geography at UCSB. This grid was overlaid with the subbasin coverage to render an average annual precipitation value for each subbasin. Table 3.2 shows the annual precipitation mean, minimum, and maximum for each of the 28 subbasins; Figure 3.2 graphically shows the variation across the watershed. The precipitation ranges from a mean of 9.8 inches at the western end, near the Otay's outlet to San Diego Bay, to almost 18 inches in the upper watershed. This significant precipitation range is the primary reason the OWPL Tool was developed, since PLOAD only allows a single mean precipitation across the watershed. Table 3.1 shows the precipitation values for the HSA areas.

Table 3.2 Land Area and Precipitation for the 28 Otay Subbasins

Planning Unit	Area (ac)	Mean (in)	Min (in)	Max (in)
OW1	4891	9.81	9.62	10.18
OW2	4891	10.34	9.92	10.76
OE1	2445	11.27	10.63	11.75
OE2	3057	10.62	10.19	10.96
OE3	1426	11.07	10.58	11.58
OE4	3464	11.06	10.45	11.87
OE5	2649	11.17	10.68	11.69
OE6	2038	11.69	11.41	12.45
OE7	4891	13.04	10.81	16.67
PV1	6725	12.91	11.37	15.84
PV2	1019	12.20	11.67	13.23
SA1	4483	11.73	11.01	13.66
SA2	3260	14.04	12.08	17.10
SA3	2445	14.43	11.99	18.26
HO1	4687	13.79	11.44	17.35
HO2	4483	15.29	11.70	19.19
HO3	2445	12.23	11.85	12.99
HO4	4891	14.34	12.04	19.38
HO5	2649	14.11	12.03	18.26
HO6	3260	12.56	11.21	14.99
HO7	3668	13.46	11.64	17.87
HO8	5909	16.62	12.50	18.83
JA1	1426	12.86	11.59	14.14
JA2	1630	12.15	11.63	12.91
JA3	4891	12.69	11.62	14.21
LE1	2445	15.05	12.97	16.26
ES1	815	11.70	11.46	11.95
LY1	2038	17.67	16.48	19.29

3.2.3 Impervious Cover

For the Simple Calculation Method used in the OWPL Tool, a percent impervious surface factor table must be provided for each land use category throughout the watershed. As shown in Section 2, it is used to calculate the runoff coefficient for each land use type. The runoff coefficient is used with the annual average rainfall to calculate the total stormwater runoff for each land use within each subbasin. Impervious surface values for land uses within the Otay Watershed were obtained from San Diego County's white paper titled "Watershed Development Districts and Impervious Cover Thresholds" (CoSDDPLU, 2003). Table 2-1 from that report, titled, Typical Percent Impervious Coverage, provided initial values that were then reviewed and adjusted as shown in Table 3.3.

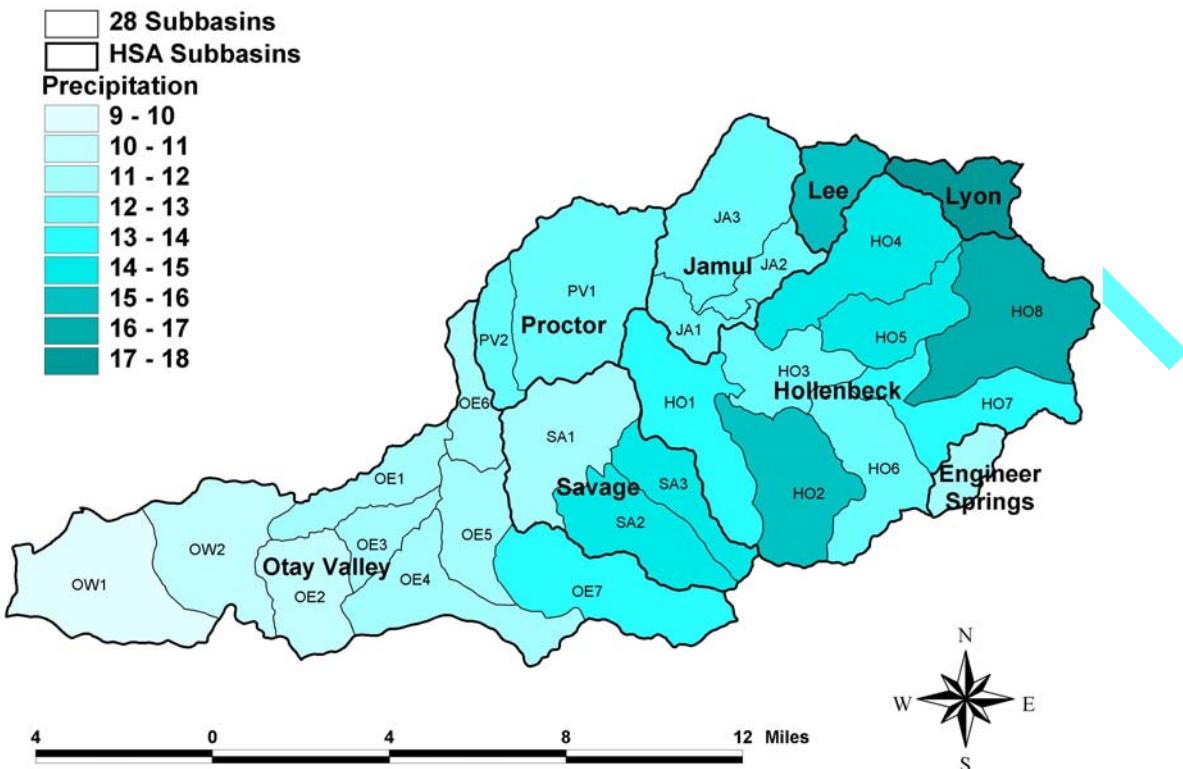


Figure 3.2 Precipitation Range across the Otay Watershed

Table 3.3 Impervious Cover for Land Uses in the Otay Watershed

White Paper		OWPL Tool	
Land Use Type	% Imp	OWPL Land Use	% Imp
Single-Family Residential (1 to 10 acres)	15 ^a	LD Res	15
Single-Family Residential (< 1 acre)	34 ^a	Mid-HD Res	40
Multi-Family Residential, Group Quarters, Hotels	68 ^b		
Industrial	91 ^b	Industrial	91
Transportation	100 ^c	Transportation	95
Airports	100 ^c		
Commercial	92 ^b	Commercial	90
Commercial Recreation	91 ^c		
Office	92 ^c		
Schools	80 ^b	Schools	80
Agriculture	0 ^c	Agriculture	2
Parks	0 ^b	Open	5
Vacant	0		
Under Construction	0	---	---
Hospital	80 ^c	Public Facilities	80
---	N/A	Public Utilities	80

^a Based on 2002 impervious surface pilot study in the San Diego River Watershed conducted by DPLU-GIS.

b Adopted from Wong et al. (1997). Los Angeles County Department of Public Works, Santa Monica Bay Drainage Study.

^c Adopted from Sleavin et al. (2000). Measuring IS for Non-Point Source Pollution Modeling.

The White paper land use categories of 'Group Quarters and Hotels' were actually aggregated and moved to the Commercial category, and not included in Mid-HD Residential. Single-family Residential accounts for 75% of the land aggregated into Mid-HD Residential, while 17% is Multi-Family Residential, and 8% is Mobile Home Parks. The Mobile Home Parks category was assumed to have the same impervious factor as Multi-Family Residential. A weighted average of 42.5% based on the three white paper land uses grouped into Mid-HD Residential was rounded down to 40% due to the extent of single family dwellings. The agriculture lands were assigned a value of 2% impervious to be more consistent with runoff expectations.

The Transportation value was decreased from 100% to 95% in order to account for road and rail rights-of-way surrounding impervious road surfaces. The Open value was increased from 0% to 5% in order to account for large expanses of exposed bedrock and shale. No information regarding impervious factors for the Public Utilities category could be found so its value was set to that of Public Facilities. Although a small amount of school and residential area was identified as being under construction, these areas were lumped into their respective categories without special consideration considering the temporary nature of construction.

3.2.4 Event Mean Concentrations (EMCs)

The EMC values selected for the Otay Watershed were derived from a variety of sources discovered during a literature review. Initially, very little data on the Otay was found, so comparable data within California and similar climatic regions were used as the only alternative. Following our initial estimation of values, San Diego Water Department (SDWD) provided data from recent sampling on both the Otay and Cottonwood watersheds (D. Daft, 2004, personal communication). Based on this more recent local data, selected EMC values were adjusted to reflect the ranges evident in the SDWD data.

Tables 3.4, 3.5, and 3.6 document the values and sources of the EMC data for each constituent/land use combination, by summarizing the data sources used and selections made to determine the specific EMC values input to the calculations. Table 3.4 contains the final input EMC values by constituent and land use. Table 3.5 notes which data sources were used as guidelines to determine each value. The priority given to each data source corresponds with its numerical ID, with 1 being the highest priority and 5 the lowest (Data source 6, referenced in the preceding paragraph, is an exception to this rule and was given highest priority). Engineering judgment was used to supersede exact literature values when deemed appropriate to maintain expected variation between land uses. Also, there was not always an exact value available for each constituent/land use combination. In these instances, values for constituents were estimated based upon an expected relation to other land uses. Table 3.6 summarizes all available values identified from the literature review. When a single value is listed, that value was reported as an EMC. When a value is followed by a range in parentheses, the first value is the algebraic mean of all samples, and the range reflects the minimum and maximum values. The SDWD data is not shown in Table 3.6 because the values were not defined by land use type, but the data we used to develop the final EMCs.

Data for TDS EMCs were very limited since TDS was not a constituent commonly measured and reported in the other data sources reviewed. The TDS values in Table 3.4 vary from 3000 mg/l for agricultural lands to 500 mg/l for recreation/open lands, with the urban categories in the range of 500 to 1000 mg/l. These values and ranges were derived from data from SDWD, Ventura County (Larry Walker Associates, 2004) and the Nevada side of the Lake Tahoe region (Carollo Engineers, 2002).

Table 3.4 Constituent Event Mean Concentrations per Land Use

Land Use Code	BOD_5 (mg/L)	TSS (mg/L)	TDS (mg/L)	NO23-N (mg/L)	NH3-N (mg/L)	TKN (mg/L)	TN (mg/L)	PO4-P (mg/L)	TP (mg/L)	T_CU (mg/L)	T_ZN (mg/L)	T_PB (mg/L)	OIL_GREASE (mg/L)	FEC_COLI (orgs/100 mL)
Agriculture	15	1500	3000	10	1.79	4.8	14.8	0.095	0.65	0.115	0.238	0.09075	0.5	5000
Commercial	34.5	70	750	0.58	0.91	3.37	3.95	0.09	0.205	0.035	0.168	0.0183	3.65	9240
Light Industrial	21	230	1000	0.86	0.48	3.07	3.93	0.07	0.22	0.031	0.399	0.0261	1.87	6550
Low Density Res.	18	50	500	0.83	0.22	2	2.83	0.08	0.13	0.15	0.056	0.015	0.68	8050
High Density Res.	38.25	100	750	1.04	0.36	2.8	3.84	0.1	0.195	0.2	0.084	0.01935	1.36	10900
Public Facility	9.15	70	500	0.58	0.91	3.37	3.95	0.09	0.205	0.035	0.168	0.0183	3.65	9240
Public Utility	21	230	1000	0.86	0.48	3.07	3.93	0.07	0.22	0.031	0.399	0.0261	1.87	6550
Rec/Open Space	3	165	375	1.11	0.1	0.81	1.92	0.025	0.055	0.012	0.028	0.00345	0.1	2180
Schools	22.5	100	500	0.63	0.26	1.62	2.25	0.1	0.155	0.022	0.084	0.015	1.36	8050
Transportation	7.5	75	625	0.75	0.23	1.81	2.56	0.1	0.22	0.052	0.196	0.033	3.19	1000

Notes: Public Facility values are set equal to those of Commercial
 Public Utility values are set equal to those of Light Industrial

Table 3.5 Sources Used to Determine Event Mean Concentrations

Land Use Category	BOD-5	TSS	TDS	NO2	NO3	NH3	TKN	TN	PO4	TP	T-Cu	T-Zn	T-Pb	F-col	Oil/Grease
Agriculture	6.5	2	6	2**	2	2	***	***	6.2	6***	1,5	6,1	6,2	5	****
Commercial	6.5	1	6	1	1	1	1	1	6.2	6,1	1	6,1	6,1	1	6,1
Light Industrial	6.5	1	6	1	1	1	1	1	6.2	6,1	1	6,1	6,1	1	6,1
Low Density Res.	6.5*	1*	6	1*	1*	1*	1*	1*	6,2*	6,1*	1,2	6,1*	6,1*	1*	6,1*
Mid-High Density Res.	6.5	1	6	1	1	1	1	1	6,2	6,1	1,2	6,1	6,1	1	6,1
Public Facility	6.5	1	6	1	1	1	1	1	6,2	6,1	1	6,1	6,1	1	6,1
Public Utility	6.5	1	6	1	1	1	1	1	6,2	6,1	1	6,1	6,1	1	6,1
Rec/Open Space	6.5	1	6	1	1	1	1	1	6,2	6,1	1	6,1	6,1	1	****
Schools	6*****	1	6	1	1	1	1	1	6*****	6,1	1	6,1	6,1	6*****	6*****
Transportation	6.5	1	6	1	1	1	1	1	6,3,4	6,1	1	6,1	6,1	1	6,1

* Low Density Res. values were estimated based upon values for other land uses, primarily Mid-High Density Res.

** Estimated as 10% of NO3 value for Agriculture

*** Proportioned to other N/P species based upon King Co work

**** Limited/no data available; assumed to be negligible and set to very low value

***** Value set to that of Mid-High Density Res.

1 = LACDPW, 2000

3 = Kayhanian et al, 2003

5 = Raird et al, 1996

2 = Ackerman and Schiff, 2003

4 = Kayhanian et al, 2002

6 = D. Daft, 2004, San Diego Water Department

Table 3.6 Available Sources of Event Mean Concentration Data

Constituent	Source	Land Use Category									
		Ag	Com	Ind	LD Res	HD Res	Pub Fac	Pub Util	Rec/Open	School	Trans
BOD-5 (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	4	23 67	14 229		25.5				N?M	
TSS (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	2068 (625-7,680)	118 (1-2,240)	174 (1-2,796)		105 102 (1-760) 41			165 28.8 (1-8,728) 70	103	75 148.1 (1-5100) 230.9 (2-29,000) 73.5
TDS (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996			0.14	0.09						
NO2 (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996			0.58	0.86	0.09			0.05	0.08	0.09 0.1 (0.05-1.7)
NO3 (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	10.0 (1.66-25.1)	0.11 (0.009-1.62)	0.066 (0.005-0.41)		1.04 0.118 (0.006-6.54)			1.11 0.02 (0.021-0.049) 0.54 **	0.63	0.75 1.1 (0.01-14.7) 1.2 (0.03-48) 0.56 **
NH3 (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	1.79 (<0.1-8.10)	0.70 (<0.05-12.2)	0.38 (<0.05-3.24)		0.36 0.53 (<0.05-6.19)			0.08 0.091 (0.072-2.09)	0.26	0.23 1.1 (0.08-6.4)
TKN (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996		3.37	3.07		2.8			0.81	1.62	1.81 2.0 (0.1-57) 2.7 (0.08-57) 1.5
TN (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996		4.09*	4.02*		3.93*			1.97*	2.33*	2.65* 3.3*
PO4	LACDPW, 2000	3.3*	1.36*	1.29*		1.73*			1.5*		2.06*

(mg/L)	Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	0.57 (0.32-0.75)	0.55 (0.02-3.10)	0.41 (0.02-1.60)	0.60 (0.16-1.4)					0.1 (0.01-1.03) 0.43 (0.01-6.0)
TP (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996		0.41	0.44	0.39			0.11	0.31	0.44 0.3 (0.01-10) 0.68 (0.01-37.5) 0.22
T_Cu (ug/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	225 (55.5-750)	34.8 32.64 (<0.1-320)	31.0 46.2 (4.0-990)	15.3 25.2 (4.0-210)			31.0 22.9 (2.0-305)	21.5	51.9 13.5 (1-121) 53 (0.2-9500) 11
T_Zn (ug/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	345 (3.30-1,150)	239 233 (25-2,130)	566 326 (1.2-5,970)	80 141 (0.073-1,610)			39 45 (13-651)	124	279 72.7 (3-1,017) 227 (2.5-4800) 60
T_Pb (ug/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996	60.48 (5.0-161)	11.53 12.22 (<1-248)	14.87 17.4 (<1- 188)	0.39 0.57			N/M 2.27 (<0.1-202)	4.53	9.08 5.4 (0.2-414) 86 (0.1-2300) 11
Oil/Grease (mg/L)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996		3.65	1.87	15.3 25.2 (4.0-210)			N/M		3.19 10.6 (1-226)
F_Coli (org/100 mL)	LACDPW, 2000 Ackerman and Schiff, 2003 Kayhanian et al, 2003 Kayhanian et al, 2002 RaIRD et al, 1996		1.07E+06	6.53E+05	80 141 (0.073-1,610)			2.18E+03		1.34E+06 6086 (2-205,000)

* taken as total of NO₂, NO₃, and TKN

** actually NO₂+NO₃

N/M : not meaningful, not enough data above detection limit

SECTION 4.0

OTAY WATERSHED POLLUTANT LOADINGS

4.1 SUMMARY POLLUTANT CONCENTRATIONS

This section provides the results of the OWPL Tool based on the input data and EMCs discussed in Section 3.0. Table 4.1 summarizes the mean pollutant concentrations and ranges calculated by the Tool compared to reported values for selected constituents from the Otay River Watershed Assessment Technical Report (Aspen, 2004) and the SDWD data. The current OWPL Tool mean values and ranges are clearly consistent with most of the mean values and within the ranges shown for the other data sources. The only major exception in this table is for Fecal Coliforms, with the reported mean values of 1805 and 120 org/100 ml being considerably lower than the OWPL mean of 4100. However, the SDWD data for the Otay and Cottonwood are considerably lower than most literature values, as shown in Table 3.6. We attempted to attain a mid range between the low SDWD values and the more common literature values, recognizing that Fecal Coliform data commonly demonstrate ranges than often span three to four orders of magnitude.

Table 4.1 Comparison of OWPL Results with Otay Report EMC values and SDWD Data

Constituent	Aspen (2004) Report EMC Value	SDWD Otay Data Mean and Range	SDWD Cottonwood Data Mean and Range	OWPL Mean and Range
BOD-5 (mg/L)	13			11.4 (3.0 – 22.7)
TSS (mg/L)	87	16.5 (0.5-657)	213.1 (0.5-2990)	146 (101 – 235)
TDS (mg/L)		405 (10-803)	664 (10-2260)	554 (375 – 800)
NO23 (mg/L)		0.4 (0-2.86)	1.58 (0.01-13.63)	1.0 (0.9 – 1.6)
NH3 (mg/L)				0.24 (0.1 – 0.4)
TKN (mg/L)	1.15			1.6 (0.8 – 2.4)
TN (mg/L)		0.65 (0.078-2.72)	3.63 (0.169-15.7)	2.7 (1.9 – 3.5)
PO4 (mg/L)		0.04 (0-1.03)	0.04 (0.01-0.13)	0.06 (0.03 – 0.09)
TP (mg/L)		0.07 (0.035-0.582)	0.1 (0.035-0.455)	0.13 (0.06 – 0.20)
T-Cu (ug/L)	21	39.48 (1-359)	56.12 (20-100)	51 (12 – 101)
T-Zn (ug/L)	115	55.64 (4-400)	409 (409-409)	110 (30 – 270)
T-Pb (ug/L)	22.1	13.35 (1-100)	328.2 (105-865)	14 (3 – 24)
Oil/Grease (mg/L)				1.14 (0.1 – 2.2)
F-col _i (orgs/100 ml)		1804.92 (8-20000)	119.5 (19-220)	4100 (1940 – 6360)

4.2 ESTIMATED RUNOFF AND POLLUTANT LOADINGS

Tables 4.2 through 4.16 show the individual tables provided in the OWPL Tool as the calculated output from the spreadsheet. The following tables are provided in order shown below:

- Table 4.2 Watershed Summary Loads by Land Use
- Table 4.3 Percent (%) of Watershed Summary Loads by Land Use
- Table 4.4 Watershed Summary Loading Rates by Land Use
- Table 4.5 Constituent Concentrations by Subbasin



Table 4.6	Total Runoff (ac-ft/yr) by Subbasin
Table 4.7	Normalized Runoff (in/yr) by Subbasin
Table 4.8	Total Suspended Solids Loads (lbs/yr) by Subbasin
Table 4.9	Total Suspended Solids Loading Rates (lbs/yr) by Subbasin
Table 4.10	BOD-5 Loads (lbs/yr) by Subbasin
Table 4.11	BOD-5 Loading Rates (lbs/yr) by Subbasin
Table 4.12	Total Dissolved Solids Loads (lbs/yr) by Subbasin
Table 4.13	Total Dissolved Solids Loading Rates (lbs/yr) by Subbasin
Table 4.14	Total Nitrogen Loads (lbs/yr) by Subbasin
Table 4.15	Total Nitrogen Loading Rates (lbs/yr) by Subbasin
Table 4.16	Total Phosphorus Loads (lbs/yr) by Subbasin
Table 4.17	Total Phosphorus Loading Rates (lbs/yr) by Subbasin

Note that the runoff and annual load tables for each constituent (as opposed to the loading rate tables) show the ‘% of watershed’ runoff and loads attributed to each land use and point source.

FINAL DRAFT

Table 4.2 Watershed Summary Loads by Land Use

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NO BMPs APPLIED

CONSTITUENT	Land Use										Pt Src Loads	Subbasin Total
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
BOD_5 (lbs/yr)	4365	29389	150243	55933	38428	6198	8916	54798	20762	47102	0	416134
TSS (lbs/yr)	436473	59631	392793	612598	106744	47413	97647	3013914	92276	471017	0	5330508
TDS (lbs/yr)	872947	638901	2945948	2663471	1067443	338668	424553	6849805	461380	3925141	0	20188254
NO23 (lbs/yr)	2909.8	494.1	4085.0	2290.6	1772.0	392.9	365.1	20275.4	581.3	4710.2	0.0	37876.4
NH3 (lbs/yr)	520.9	775.2	1414.1	1278.5	469.7	616.4	203.8	1826.6	239.9	1444.5	0.0	8789.4
TKN (lbs/yr)	1397	2871	10998	8177	4270	2283	1303	14796	1495	11367	0	58956
TN (lbs/yr)	4307	3365	15083	10467	6042	2675	1668	35071	2076	16077	0	96832
PO4 (lbs/yr)	27.6	76.7	392.8	186.4	170.8	61.0	29.7	456.7	92.3	628.0	0.0	2122.0
TP (lbs/yr)	189.1	174.6	765.9	586.0	277.5	138.9	93.4	1004.6	143.0	1381.6	0.0	4754.8
T_CU (lbs/yr)	33.46	29.82	785.59	82.57	320.23	23.71	13.16	219.19	20.30	326.57	0.00	1854.60
T_ZN (lbs/yr)	69.3	143.1	329.9	1062.7	119.6	113.8	169.4	511.5	77.5	1230.9	0.0	3827.7
T_PB (lbs/yr)	26.41	15.59	76.01	69.52	32.02	12.40	11.08	63.02	13.84	207.25	0.00	527.12
OIL_GREASE (lbs/yr)	145.5	3109.3	5342.0	4980.7	1451.7	2472.3	793.9	1826.6	1255.0	20033.9	0.0	41410.9
FEC_COLI (orgs/yr)	6.60E+12	3.57E+13	1.94E+14	7.91E+13	7.79E+13	2.84E+13	1.26E+13	1.81E+14	3.37E+13	2.85E+13	0.00E+00	6.77E+14
FLOW (acre-ft/yr)	107.0	313.2	1444.1	979.2	784.9	249.0	156.1	6715.5	339.2	2308.9	0.0	13397.1

Table 4.3 Percent (%) of Total Watershed Loads by Land Use

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NO BMPs APPLIED

CONSTITUENT	Land Use										Pt Src Loads	Subbasin Total
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
BOD_5	1.05%	7.06%	36.10%	13.44%	9.23%	1.49%	2.14%	13.17%	4.99%	11.32%	0.00%	100.00%
TSS	8.19%	1.12%	7.37%	11.49%	2.00%	0.89%	1.83%	56.54%	1.73%	8.84%	0.00%	100.00%
TDS	4.32%	3.16%	14.59%	13.19%	5.29%	1.68%	2.10%	33.93%	2.29%	19.44%	0.00%	100.00%
NO23-N	7.68%	1.30%	10.79%	6.05%	4.68%	1.04%	0.96%	53.53%	1.53%	12.44%	0.00%	100.00%
NH3-N	5.93%	8.82%	16.09%	14.55%	5.34%	7.01%	2.32%	20.78%	2.73%	16.43%	0.00%	100.00%
TKN	2.37%	4.87%	18.65%	13.87%	7.24%	3.87%	2.21%	25.10%	2.54%	19.28%	0.00%	100.00%
TN	4.45%	3.47%	15.58%	10.81%	6.24%	2.76%	1.72%	36.22%	2.14%	16.60%	0.00%	100.00%
PO4-P	1.30%	3.61%	18.51%	8.79%	8.05%	2.87%	1.40%	21.52%	4.35%	29.60%	0.00%	100.00%
TP	3.98%	3.67%	16.11%	12.32%	5.84%	2.92%	1.96%	21.13%	3.01%	29.06%	0.00%	100.00%
T_CU	1.80%	1.61%	42.36%	4.45%	17.27%	1.28%	0.71%	11.82%	1.09%	17.61%	0.00%	100.00%
T_ZN	1.81%	3.74%	8.62%	27.76%	3.12%	2.97%	4.43%	13.36%	2.03%	32.16%	0.00%	100.00%
T_PB	5.01%	2.96%	14.42%	13.19%	6.08%	2.35%	2.10%	11.96%	2.63%	39.32%	0.00%	100.00%
OIL_GREASE	0.35%	7.51%	12.90%	12.03%	3.51%	5.97%	1.92%	4.41%	3.03%	48.38%	0.00%	100.00%
FEC_COLI	0.97%	5.27%	28.67%	11.68%	11.51%	4.19%	1.86%	26.66%	4.97%	4.21%	0.00%	100.00%
FLOW	0.80%	2.34%	10.78%	7.31%	5.86%	1.86%	1.17%	50.13%	2.53%	17.23%	0.00%	100.00%

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NO BMPs APPLIED

Table 4.4 Watershed Summary Loading Rates by Land Use

CONSTITUENT	Land Use										Pt Src Loads	Subbasin Total
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
BOD_5 (lbs/ac/yr)	2.5	57.8	31.4	37.0	9.3	15.9	34.2	0.7	35.5	14.5	4.5	4.5
TSS (lbs/ac/yr)	250	117	82	405	26	122	375	40	158	145	57	57
TDS (lbs/ac/yr)	500	1256	616	1762	257	868	1629	90	789	1207	217	217
NO23 (lbs/ac/yr)	1.67	0.97	0.85	1.52	0.43	1.01	1.40	0.27	0.99	1.45	0.41	0.41
NH3 (lbs/ac/yr)	0.30	1.52	0.30	0.85	0.11	1.58	0.78	0.02	0.41	0.44	0.09	0.09
TKN (lbs/ac/yr)	0.8	5.6	2.3	5.4	1.0	5.8	5.0	0.2	2.6	3.5	0.6	0.6
TN (lbs/ac/yr)	2.5	6.6	3.2	6.9	1.5	6.9	6.4	0.5	3.6	4.9	1.0	1.0
PO4 (lbs/ac/yr)	0.02	0.15	0.08	0.12	0.04	0.16	0.11	0.01	0.16	0.19	0.02	0.02
TP (lbs/ac/yr)	0.11	0.34	0.16	0.39	0.07	0.36	0.36	0.01	0.24	0.42	0.05	0.05
T_CU (lbs/ac/yr)	0.019	0.059	0.164	0.055	0.077	0.061	0.051	0.003	0.035	0.100	0.020	0.020
T_ZN (lbs/ac/yr)	0.04	0.28	0.07	0.70	0.03	0.29	0.65	0.01	0.13	0.38	0.04	0.04
T_PB (lbs/ac/yr)	0.015	0.031	0.016	0.046	0.008	0.032	0.043	0.001	0.024	0.064	0.006	0.006
OIL_GREASE (lbs/ac/yr)	0.08	6.11	1.12	3.30	0.35	6.34	3.05	0.02	2.15	6.16	0.45	0.45
FEC_COLI (orgs/ac/yr)	3.78E+09	7.02E+10	4.06E+10	5.24E+10	1.88E+10	7.27E+10	4.84E+10	2.38E+09	5.76E+10	8.76E+09	7.29E+09	7.29E+09
FLOW (in/ac/yr)	0.74	7.39	3.62	7.78	2.27	7.66	7.19	1.06	6.96	8.52	1.73	1.73

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NO BMPs APPLIED

Table 4.5 Constituent Concentrations by Subbasin

Model Segment	BOD_5 (mg/L)	TSS (mg/L)	TDS (mg/L)	NO23 (mg/L)	NH3 (mg/L)	TKN (mg/L)	TN (mg/L)	PO4 (mg/L)	TP (mg/L)	T_CU (mg/L)	T_ZN (mg/L)	T_PB (mg/L)	OIL_GREASE (mg/L)	FEC_COLI (orgs/100 mL)	
Engineer Springs	8.5	171	543	1.32	0.22	1.5	2.8	0.05	0.12	0.061	0.07	0.014	0.69	3.94E+03	
Hollenbeck	HO1	3.9	165	409	1.09	0.12	0.9	2.0	0.03	0.07	0.014	0.05	0.005	0.26	2.33E+03
	HO2	3.0	165	376	1.11	0.10	0.8	1.9	0.03	0.06	0.012	0.03	0.004	0.11	2.18E+03
	HO3	3.4	157	398	1.08	0.11	0.9	2.0	0.03	0.07	0.016	0.04	0.006	0.39	2.07E+03
	HO4	4.9	146	408	1.05	0.12	1.0	2.1	0.04	0.08	0.030	0.04	0.007	0.41	2.70E+03
	HO5	5.7	170	469	1.23	0.16	1.1	2.4	0.04	0.09	0.037	0.05	0.009	0.45	2.96E+03
	HO6	3.0	165	375	1.11	0.10	0.8	1.9	0.03	0.06	0.012	0.03	0.004	0.11	2.18E+03
	HO7	4.6	235	556	1.61	0.22	1.2	2.8	0.04	0.11	0.025	0.05	0.011	0.37	2.50E+03
	HO8	7.5	133	451	1.05	0.16	1.3	2.3	0.05	0.10	0.053	0.05	0.010	0.59	3.63E+03
Hollenbeck		4.9	161	430	1.14	0.14	1.0	2.2	0.04	0.08	0.028	0.05	0.007	0.36	2.72E+03
Jamul	JA1	3.0	165	375	1.11	0.10	0.8	1.9	0.03	0.06	0.012	0.03	0.003	0.10	2.18E+03
	JA2	4.7	211	519	1.46	0.19	1.1	2.6	0.04	0.10	0.027	0.05	0.010	0.41	2.49E+03
	JA3	10.8	146	538	1.16	0.22	1.5	2.7	0.06	0.13	0.067	0.07	0.015	0.88	4.52E+03
Jamul		9.0	157	515	1.20	0.20	1.4	2.6	0.05	0.11	0.054	0.07	0.013	0.71	3.95E+03
Lee		9.1	137	478	1.12	0.18	1.4	2.5	0.05	0.10	0.068	0.05	0.011	0.51	4.38E+03
Lyon		7.7	162	516	1.23	0.21	1.4	2.6	0.05	0.11	0.052	0.07	0.013	0.76	3.59E+03
Otay Valley	OVE1	15.8	122	608	0.90	0.26	1.9	2.8	0.08	0.16	0.067	0.14	0.020	1.67	4.78E+03
	OVE2	16.8	179	800	0.89	0.37	2.4	3.3	0.07	0.19	0.044	0.27	0.023	1.81	5.20E+03
	OVE3	9.0	186	583	1.03	0.23	1.6	2.6	0.04	0.11	0.019	0.15	0.011	0.69	3.65E+03
	OVE4	9.4	231	727	1.44	0.40	2.0	3.5	0.06	0.17	0.031	0.17	0.020	1.44	4.06E+03
	OVE5	5.5	154	434	1.08	0.20	1.2	2.3	0.04	0.09	0.026	0.06	0.008	0.70	3.13E+03
	OVE6	15.9	103	605	0.90	0.24	1.9	2.8	0.08	0.18	0.083	0.13	0.022	1.95	4.35E+03
	OVE7	5.0	153	433	1.02	0.26	1.4	2.4	0.04	0.09	0.017	0.07	0.007	0.82	3.63E+03
	OVW1	21.5	117	711	0.86	0.37	2.4	3.2	0.09	0.20	0.083	0.18	0.023	2.18	6.02E+03
	OVW2	22.7	101	691	0.86	0.36	2.4	3.2	0.09	0.20	0.101	0.15	0.024	2.24	6.36E+03
		17.4	134	667	0.94	0.34	2.1	3.1	0.08	0.18	0.069	0.16	0.021	1.85	5.31E+03
Proctor	PV1	6.0	158	426	1.09	0.13	1.1	2.2	0.03	0.07	0.030	0.05	0.006	0.30	3.00E+03
	PV2	5.3	151	443	1.04	0.14	1.1	2.1	0.04	0.09	0.025	0.07	0.009	0.66	2.40E+03
		5.9	156	429	1.09	0.14	1.1	2.1	0.04	0.08	0.029	0.05	0.007	0.37	2.89E+03
Savage	SA1	3.8	152	412	1.06	0.12	1.0	2.0	0.04	0.08	0.019	0.05	0.008	0.55	2.06E+03
	SA2	3.0	165	375	1.11	0.10	0.8	1.9	0.03	0.06	0.012	0.03	0.003	0.10	2.18E+03
	SA3	4.0	146	429	1.03	0.13	1.0	2.1	0.04	0.09	0.020	0.06	0.010	0.75	1.94E+03
Savage		3.6	155	405	1.07	0.12	0.9	2.0	0.03	0.07	0.017	0.05	0.007	0.46	2.06E+03
Watershed Average		11.4	146	554	1.04	0.24	1.6	2.7	0.06	0.13	0.051	0.11	0.014	1.14	4.10E+03

Table 4.6 Total Runoff (ac-ft/yr) by Subbasin

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NO BMPs APPLIED

Model Segment	Land Use										Pt Src Loads	Subbasin Total	% of HSA Total	% of Watershed Total	
	AG	COM	HD RES	IND	LD RES	PUB FAC	PUB UTIL	REC/OPEN	SCHOOL	TRANS					
Engineer Springs	4.9		0.2		37.3	1.2	0.1	69.2		15.2		128.2	100.0%	1.0%	
Hollenbeck	HO1				19.0			417.3		12.7		448.9	13.2%	3.4%	
	HO2							439.3		1.1		440.4	12.9%	3.3%	
	HO3							213.1		22.0		235.0	6.9%	1.8%	
	HO4	0.0			56.0			436.1		42.2		534.4	15.7%	4.0%	
	HO5	6.2			41.0			222.1		24.3		293.6	8.6%	2.2%	
	HO6							310.1		0.5		310.7	9.1%	2.3%	
	HO7	20.2	0.5	0.7	9.4	1.6		280.3		22.7		335.5	9.9%	2.5%	
	HO8	5.0			211.4	2.4		501.9		85.8		806.5	23.7%	6.0%	
Hollenbeck	31.5	0.5	0.7	19.0	317.9	4.0		2820.1		211.4	0.0	3405.1	100.0%	25.4%	
Jamul	JA1							116.0				116.0	12.8%	0.9%	
	JA2	5.4						101.1				123.1	13.6%	0.9%	
	JA3	17.0	3.3	13.6		200.8	3.5	6.1	286.8		43.3	93.1	667.5	73.6%	5.0%
	Jamul	22.4	3.3	13.6		206.6	3.5	6.3	503.9		43.3	103.6	0.0	906.6	100.0%
Lee	4.2				103.7			149.3				273.3	100.0%	2.0%	
Lyon	9.1	2.9			72.5	5.7		191.2				325.9	100.0%	2.4%	
Otay Valley	OVE1	0.5	102.7	39.9	1.0	2.9	9.2	129.1		57.7	154.8	497.9	7.6%	3.7%	
	OVE2	0.1	7.4	54.6	424.4	10.3		130.1			134.2	761.2	11.6%	5.7%	
	OVE3				48.2	0.6		103.6				155.8	2.4%	1.2%	
	OVE4	28.0			117.3	0.4	58.9	1.4	213.3			493.7	7.5%	3.7%	
	OVE5	1.2				21.1			182.0			230.7	3.5%	1.7%	
	OVE6							3.6	90.7	22.5	204.0	441.6	6.7%	3.3%	
	OVE7	0.7				0.4	91.3	26.2	404.7			525.0	8.0%	3.9%	
	OVW1	2.1	175.6	474.3	237.3	1.6	5.6	52.6	120.9	109.5	558.8	1738.3	26.5%	13.0%	
Otay Valley	OVW2	1.4	122.9	634.8	92.6	0.9	44.4	32.8	55.5	106.1	620.8	1712.2	26.1%	12.8%	
	Otay Valley	33.5	306.5	1397.0	959.8	4.9	234.5	129.2	1430.0	295.9	1765.1	0.0	6556.3	100.0%	48.9%
Proctor	PV1	1.4		26.8		40.5		16.2	543.7		14.5	643.0	81.0%	4.8%	
	PV2			4.5		0.5		4.4	118.7		23.2	151.3	19.0%	1.1%	
	Proctor	1.4		31.2		40.9		20.6	662.4		37.8	794.3	100.0%	5.9%	
Savage	SA1			1.3		1.1			345.4		58.0	405.8	40.3%	3.0%	
	SA2			0.5					329.7			329.7	32.7%	2.5%	
	SA3			0.5		1.1			214.2		57.3	271.9	27.0%	2.0%	
	Savage			1.3		0.5			889.3		115.2	1007.4	100.0%	7.5%	
Land Use Total	107.0	313.2	1444.1	979.2	784.9	249.0	156.1	6715.5	339.2	2308.9	0.0	13397.1			
% of Watershed Total	0.8%	2.3%	10.8%	7.3%	5.9%	1.9%	1.2%	50.1%	2.5%	17.2%	0.0%				

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NO BMPs APPLIED**Table 4.7 Normalized Runoff (in/yr) by Subbasin**

Model Segment	Land Use										Subbasin w/o Pt Src	Subbasin w/ Pt Src	
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS			
Engineer Springs	0.68		4.08		1.84	7.66	7.66	0.94			9.00	1.25	1.25
HO1				10.18				1.11			10.60	1.19	1.19
								1.23			11.76	1.24	1.24
								0.99			9.41	1.08	1.08
	0.83				2.26			1.16			11.03	1.32	1.32
	0.82				2.22			1.14			10.85	1.31	1.31
								1.01			9.66	1.02	1.02
	0.78	9.84	4.69		2.12	8.81		1.09			10.35	1.15	1.15
	0.96				2.61	10.88		1.34			12.79	1.73	1.73
Hollenbeck	0.81	9.84	4.69	10.18	2.47	9.94		1.15			11.33	1.29	1.29
JA1								1.04				1.04	1.04
	0.70				1.91			7.95				1.07	1.07
	0.73	9.28	4.42		2.00	8.31		8.31			9.35	1.58	1.58
Jamul	0.73	9.28	4.42		1.99	8.31		8.29			8.31	9.72	1.40
Lee	0.87				2.37						1.22		1.58
Lyon	1.02	12.92			2.78	11.57					13.59	1.88	1.88
OVE1	8.24		3.93	8.33	1.77	7.38		7.38			7.38	8.67	2.48
	0.61	7.76	3.70	7.84		6.95						8.17	3.18
				8.17	1.74			7.24					1.27
	0.64			8.17	1.74	7.24		7.24					1.57
	0.65		3.89			7.31						8.60	1.09
		4.07						7.65				8.99	2.91
	0.75			2.05		8.53		8.53				10.03	1.31
	0.57	7.17	3.42	7.25	1.54	6.42		6.42			6.42	7.55	3.83
	0.60	7.56	3.60	7.64	1.63	6.77		6.77			6.77	7.95	4.52
Otay Valley	0.63	7.34	3.60	7.74	1.68	7.56		6.99			6.80	8.03	2.65
PV1	0.75			4.50			2.03					9.93	1.16
				4.25			1.92					9.39	1.21
	0.75		4.46				2.03					9.59	1.17
Proctor								8.45					
								7.99					
	0.75							8.35					
SA1				4.09							0.95		1.09
				10.66			1.85				1.13		1.13
				10.66			1.85				1.17		1.44
Savage				4.09							1.06		1.18
											11.10		1.44
											9.95		1.18
Land Use Average	0.74	7.39	3.62	7.78	2.27	7.66	7.19	1.06	6.96	8.52	1.73	1.73	

Table 4.8 Total Suspended Solids Loads (lbs/yr) by Subbasin

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NO BMPs APPLIED

Model Segment	Land Use										Pt Src Loads	Subbasin Total	% of HSA Total	% of Watershed Total		
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS						
Engineer Springs	19943		63		5077	233	42	31064		3106		59528	100.0%	1.1%		
Hollenbeck	HO1				11858			187267		2583		201708	13.5%	3.8%		
	HO2							197148		225		197373	13.2%	3.7%		
	HO3							95618		4486		100104	6.7%	1.9%		
	HO4	63				7622		195710		8617		212012	14.2%	4.0%		
	HO5	25478				5577		99656		4965		135676	9.1%	2.5%		
	HO6							139191		112		139303	9.3%	2.6%		
	HO7	82456	92	201		1283	311	125816		4632		214791	14.4%	4.0%		
	HO8	20369				28748	460	225261		17506		292344	19.6%	5.5%		
Hollenbeck	128367	92	201	11858	43230	770		1265668		43126	0	1493312	100.0%	28.0%		
Jamul	JA1							52064				52064	13.4%	1.0%		
	JA2	22168				790		45392		2137		70629	18.2%	1.3%		
	JA3	69290	623	3693		27310	672	3797		128702		264872	68.3%	5.0%		
	Jamul	91458	623	3693		28100	672	3938		226158		21137	0	387564	100.0%	7.3%
Lee	17230					14100				67010		3282		101621	100.0%	1.9%
Lyon	37056	559				9855	1088			85827		9080		143464	100.0%	2.7%
Otay Valley	OVE1	103	27933	24936		140	548	5730		57961	15707	31587	164646	6.9%	3.1%	
	OVE2	383	1412	14859	265531		1960			58402		27375	369921	15.5%	6.9%	
	OVE3			30176		82		2103		46475			78836	3.3%	1.5%	
	OVE4	114153		73408		48	11212	865		95736			310604	13.0%	5.8%	
	OVE5	5011		2681			4023			81691			96761	4.1%	1.8%	
	OVE6			32840				2276		40698	6127	41616	123557	5.2%	2.3%	
	OVE7	3013				57	17376	16417		181636		326	218825	9.2%	4.1%	
	OVW1	8449	33437	129005	148476	220	1073	32907		54254	29792	113990	551603	23.1%	10.3%	
	OVW2	5661	23405	172670	57913	118	8458	20504		24927	28865	126642	469164	19.7%	8.8%	
Otay Valley	136669	58357	379989	600441	665	44650	80803		641778	80491	360074	0	2383918	100.0%	44.7%	
Proctor	PV1	5749			7278		5503		10120	244008		2965	275624	81.6%	5.2%	
	PV2	5749			1212		65		2744	53291		4739	62050	18.4%	1.2%	
	Proctor	5749			8490		5568		12864	297299		7704	0	337674	100.0%	6.3%
Savage	SA1			356		151				155015		11822	167345	39.5%	3.1%	
	SA2				299					147978			147978	34.9%	2.8%	
	SA3			356	299	151				96116		11687	108102	25.5%	2.0%	
	Savage									399109		23509	0	423425	100.0%	7.9%
Land Use Total	436473	59631	392793	612598	106744	47413	97647	3013914	92276	471017	0	5330508				
% of Watershed Total	8.2%	1.1%	7.4%	11.5%	2.0%	0.9%	1.8%	56.5%	1.7%	8.8%	0.0%					

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NO BMPs APPLIED

Table 4.9 Total Suspended Solids Loading Rates (lbs/ac/yr) by Subbasin

Model Segment	Land Use										Subbasin w/o Pt Src	Subbasin w/ Pt Src
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
Engineer Springs	230		92		21	121	399	35		153	48	48
HO1					531			42		180	44	44
						26		46		200	46	46
						25		37		160	38	38
	282					24		43		188	44	44
	277					30		43		184	51	51
						140		38		164	38	38
						173		41		176	62	62
	265	156	106		28	158		50		217	52	52
Hollenbeck	327	156	106	531				43		193	47	47
JA1								39			39	39
	239					22		415		159	51	51
	249	147	100			23	132	433	38	188	52	52
Jamul	247	147	100		23	132	432	38	188	165	50	50
Lee	296				27			45		197	49	49
Lyon	347	205			31	184		53		231	69	69
OVE1	131		89	434	20	117		34	167	147	68	68
	209	123	84	409		110		32		139	129	129
			426		20		378	33			54	54
	217		426		20	115	378	33		145	82	82
	220		88			116		34		146	38	38
			92		23		399	35	173	153	68	68
	256		78	378	17	135	445	39		170	46	46
	193	114	82	398	18	102	335	30	146	128	101	101
	203	120	82	398	19	107	353	31	153	135	103	103
	216	116	82	403		120	364	35	154	136	80	80
PV1	254		102		23		441	39		169	42	42
			96		22		416	37		160	41	41
	254		101		23		435	39		163	42	42
SA1								35		153	37	37
			93		21			42			42	42
			93	556	21			44		189	48	48
Savage			556	556				40		169	41	41
Land Use Average	250	117	82	405	26	122	375	40	158	145	57	57

Table 4.10 BOD-5 Loads (lbs/yr) by Subbasin

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NO BMPs APPLIED

Model Segment	Land Use										Pt Src Loads	Subbasin Total	% of HSA Total	% of Watershed Total
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS				
Engineer Springs	199		24		1828	30	4	565		311		2961	100.0%	0.7%
Hollenbeck	HO1				1083			3405	258			4746	10.4%	1.1%
	HO2							3585	22			3607	7.9%	0.9%
	HO3							1739	449			2187	4.8%	0.5%
	HO4	1				2744		3558	862			7165	15.8%	1.7%
	HO5	255				2008		1812	496			4571	10.1%	1.1%
	HO6							2531	11			2542	5.6%	0.6%
	HO7	825	45	77		462	41	2288	463			4200	9.2%	1.0%
	HO8	204				10349	60	4096	1751			16459	36.2%	4.0%
Hollenbeck	1284	45	77	1083	15563	101		23012	4313	0		45477	100.0%	10.9%
Jamul	JA1					284		947				947	4.3%	0.2%
	JA2	222						825				1558	7.1%	0.4%
	JA3	693	307	1413		9832	88	2340	2652			19570	88.7%	4.7%
	Jamul	915	307	1413		10116	88	347	1900			22075	100.0%	5.3%
Lee	172					5076		1218				6795	100.0%	1.6%
Lyon	371	275				3548	142		1560			6804	100.0%	1.6%
Otay Valley	OVE1		51	10684	2277	50	72	523		1054	3534	3159	6.9%	5.1%
	OVE2	4	696	5684	24244		256			1062		2737	34683	11.2%
	OVE3			2755		30		192		845			3822	1.2%
	OVE4	1142		6702		17	1466	79		1741			12665	4.1%
	OVE5	50		1025			526			1485			3422	1.1%
	OVE6			12561				208		740	1379	4162	19049	6.2%
	OVE7	30						1499		3302			7156	2.3%
	OVW1	84	16479	49345	13557	21	2271			986	6703	11399	101778	32.9%
	OVW2	57	11536	66046	5288	42	1106	1872		453	6495	12664	105559	34.1%
Otay Valley	1367	28762	145346	54823	239	5836	7378	11669	18111	36007	0	309537	100.0%	74.4%
Proctor	PV1	57			2784		1981			924	4437		10480	82.8%
	PV2				464	23				250	969		2180	17.2%
	Proctor	57			3248	2004				1175	5405	770	12660	100.0%
Savage	SA1				136					2818		1182	4191	42.7%
	SA2				27					2691			2691	27.4%
	SA3				27		54			1748		1169	2944	30.0%
	Savage				54					7257		2351	9825	0.7%
												0	100.0%	2.4%
Land Use Total	4365	29389	150243	55933	38428	6198	8916	54798	20762	47102	0	416134		
% of Watershed Total	1.0%	7.1%	36.1%	13.4%	9.2%	1.5%	2.1%	13.2%	5.0%	11.3%	0.0%			

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NO BMPs APPLIED**Table 4.11 BOD-5 Loading Rates (lbs/ac/yr) by Subbasin**

Model Segment	Land Use										Subbasin w/o Pt Src	Subbasin w/ Pt Src
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
Engineer Springs	2.3		35.3		7.5	15.9	36.4	0.6		15.3	2.4	2.4
HO1				48.5				0.8		18.0	1.0	1.0
					9.2			0.8		20.0	0.8	0.8
					9.1			0.7		16.0	0.8	0.8
	2.8				8.6	18.3		0.8		18.8	1.5	1.5
	2.8				10.7	22.6		0.8		18.4	1.7	1.7
								0.7		16.4	0.7	0.7
	2.6	76.9	40.7		8.6			0.7		17.6	1.2	1.2
	3.3	76.9	40.7	48.5	10.7	22.6		0.9		21.7	2.9	2.9
Hollenbeck	2.8	76.9	40.7	48.5	10.1	20.6		0.8		19.3	1.4	1.4
JA1								0.7			0.7	0.7
	2.4				7.8		37.9	0.7			15.9	1.1
	2.5	72.6	38.4		8.1	17.2	39.5	0.7	42.4	16.6	3.9	3.9
Jamul	2.5	72.6	38.4		8.1	17.2	39.5	0.7	42.4	16.5	2.8	2.8
Lee	3.0				9.7			0.8		19.7	3.3	3.3
Lyon	3.5	101.0			11.3	24.0		1.0		23.1	3.3	3.3
OVE1	64.4		34.1	39.6	7.2	15.3		0.6	37.6	14.7	8.9	8.9
	2.1	60.7	32.1	37.3		14.4		0.6		13.9	12.1	12.1
			38.9		7.1		34.5	0.6			2.6	2.6
	2.2		38.9		7.1	15.0	34.5	0.6		14.5	3.4	3.4
	2.2		33.8			15.2		0.6		14.6	1.4	1.4
		35.3					36.4	0.6	39.0	15.3	10.5	10.5
	2.6			8.4		17.7	40.6	0.7		17.0	1.5	1.5
	1.9	56.1	29.7	34.5	6.3	13.3	30.6	0.5	32.8	12.8	18.7	18.7
	2.0	59.1	31.2	36.3	6.6	14.0	32.2	0.6	34.5	13.5	23.2	23.2
Otay Valley	2.2	57.4	31.2	36.8	6.8	15.7	33.3	0.6	34.7	13.6	10.4	10.4
PV1	2.5			39.0		8.3		0.7		16.9	1.6	1.6
			36.9		7.8		38.0	0.7		16.0	1.5	1.5
	2.5		38.7		8.3		39.7	0.7		16.3	1.6	1.6
SA1				35.5				0.6		15.3	0.9	0.9
				50.7				0.8			0.8	0.8
			35.5	50.7	7.5			0.8		18.9	1.3	1.3
Savage								0.7		16.9	1.0	1.0
Land Use Average	2.5	57.8	31.4	37.0	9.3	15.9	34.2	0.7	35.5	14.5	4.5	4.5

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Table 4.12 Total Dissolved Solids Loads (lbs/yr) by Subbasin

Model Segment	Land Use										Pt Src Loads	Subbasin Total	% of HSA Total	% of Watershed Total	
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS					
Engineer Springs	39887		476		50768	1664	181	70601		25882		189457	100.0%	0.9%	
HO1					51557				425607	21525		498689	12.5%	2.5%	
									448064	1874		449939	11.3%	2.2%	
									217314	37386		254700	6.4%	1.3%	
									444796	71807		592948	14.9%	2.9%	
									226492	41371		374591	9.4%	1.9%	
									316344	932		317275	8.0%	1.6%	
									285945	38602		507002	12.7%	2.5%	
									511957	145887		989342	24.8%	4.9%	
Hollenbeck	127	50956	986	1507	51557	12830	2220		2876518	359385	0	3984486	100.0%	19.7%	
JA1									118327			118327	9.3%	0.6%	
		44336							103164			173825	13.7%	0.9%	
		138580	6674	27700		273102	4796	615	292506	58924		977120	77.0%	4.8%	
Jamul	182916	6674	27700		281000	4796	17124		513996	58924	176141	0	1269271	100.0%	6.3%
Lee	34461				140995				152294			27346		1.8%	
Lyon	74112	5985			98545	7773			195062			75664		2.3%	
OVE1		1104	209499	108419	1401	3913	24914		131731	78535	263226	822740	6.9%	4.1%	
		766	15131	111445	1154481	14001			132731		228122	1656676	13.9%	8.2%	
				131201	822	9142			105626			246791	2.1%	1.2%	
				319166	477	80089	3762		217582			975896	8.2%	4.8%	
						28737			185661			272493	2.3%	1.3%	
									9897			346801	726128	6.1%	
									71380			2716	617617	5.2%	
									143075			148962	949919	28.3%	
OVW1	228306	20104	246301		571	124117			123303			9949919	3363354	16.7%	
	10021					2197			140412			1055349	3215987	27.0%	
	6026	16898	358249	967539	645548	1179	6646	318932	351319	1458587	402456	3000616	0	11897680	58.9%
Otay Valley	273338	625257	2849916	2610612											
	PV1	11499			54585				44001	554565		24708	744389	80.3%	3.7%
	PV2	11499			9093				11928	121116		39488	182271	19.7%	0.9%
Proctor			63678		55677				55929	675680		64196	926660	100.0%	4.6%
	SA1				2671										
	SA2				1302										
Savage					1302										
	SA3				1514										
Land Use Total	872947	638901	2945948	2663471	1067443	338668	424553	6849805	461380	3925141	0	20188254			
% of Watershed Total	4.3%	3.2%	14.6%	13.2%	5.3%	1.7%	2.1%	33.9%	2.3%	19.4%	0.0%				

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NO BMPs APPLIED**Table 4.13 Total Dissolved Solids Loading Rates (lbs/ac/yr) by Subbasin**

Model Segment	Land Use										Subbasin w/o Pt Src	Subbasin w/ Pt Src
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
Engineer Springs	460		693		208	868	1735	80			1275	154
HO1				2308				95			1502	110
					256			105			1666	105
					251			84			1333	97
	564					999		98			1563	122
	554							97			1537	140
								86			1369	86
								92			1467	145
	529	1673	798	2308	240	1233		114			1812	177
Hollenbeck	653	1673	798		296			98			1605	126
	551	1673	798	2308	280	1126						126
JA1								88				88
	478				217			1803			1324	126
	499	1577	752		226	942		1883			1383	193
Jamul	494	1577	752		226	942		1880			1377	163
												163
Lee	592				268				103		1640	171
Lyon	695	2196			315	1311			121		1926	220
OVE1	1401		668	1887	201	836		1672		77	836	1228
	417	1319	629	1778		788				73		1157
				1853	197			1642		76		168
	435			1853	197	821		1641		76		1206
	439		662			829				77		1218
			693		232			1735		80	867	1274
	512		581	1643	175	967		1934		89		1421
	386	1220	612	1731	184	728		1456		67	728	1069
	406	1285	612	1754	190	767		1534		71	767	1126
Otay Valley	432	1247	612	1754		856		1584		78	771	1137
PV1	507			765			230		1915		89	1407
				723			218		1811		84	1330
	507			759			230		1892		88	1359
Proctor												114
												114
												114
SA1				695			209			81		1279
				2416						96		102
				2416			209			99		96
Savage				695						90		1573
				2416						1410		140
				2416						108		108
Land Use Average	500	1256	616	1762	257	868	1629	90	789	1207	217	217

Table 4.14 Total Nitrogen Loads (lbs/yr) by Subbasin

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NO BMPs APPLIED

Model Segment	Land Use										Pt Src Loads	Subbasin Total	% of HSA Total	% of Watershed Total
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS				
Engineer Springs	197		2		287	13	1	361		106		968	100.0%	1.0%
HO1								2179		88		2470	12.2%	2.6%
HO2								2294		8		2302	11.4%	2.4%
HO3								1113		153		1266	6.3%	1.3%
HO4	1					431		2277		294		3003	14.9%	3.1%
HO5	251					316		1160		169		1896	9.4%	2.0%
HO6								1620		4		1623	8.0%	1.7%
HO7	814	5	8		73	18		1464		158		2539	12.6%	2.6%
HO8	201				1627	26		2621		598		5073	25.1%	5.2%
Hollenbeck	1267	5	8	203	2447	43		14728		1472	0	20172	100.0%	20.8%
JA1								606				606	9.5%	0.6%
JA2	219					45	2	528				867	13.6%	0.9%
JA3	684	35	142		1546	38	65	1498	265	649		4920	77.0%	5.1%
Jamul	902	35	142		1590	38	67	2632	265	721	0	6393	100.0%	6.6%
Lee	170				798			780		112		1860	100.0%	1.9%
Lyon	366	32			558	61		999		310		2325	100.0%	2.4%
OVE1		6	1073	426	8	31	98	674	353	1078		3747	6.8%	3.9%
OVE2	4	80	571	4537		111		680		934		6916	12.6%	7.1%
OVE3			516		5		36	541				1097	2.0%	1.1%
OVE4	1126		103	1254	3	633	15	1114		518		4663	8.5%	4.8%
OVE5	49		1261			227		951		115		1445	2.6%	1.5%
OVE6							39	474	138	1420		3332	6.1%	3.4%
OVE7	30						281	2114		11		3419	6.2%	3.5%
OVW1	83	1887	4954	2537	12	981	61	562	670	3891		15289	27.8%	15.8%
OVW2	56	1321	6631	990	7	477		350	290	649		15093	27.4%	15.6%
Otay Valley	1348	3293	14592	10260	38	2520	1381	7468	1811	12291	0	55000	100.0%	56.8%
PV1	57				279	311		2839		101		3761	81.1%	3.9%
PV2					47		47	620		162		879	18.9%	0.9%
Proctor	57				326	4		3459		263	0	4640	100.0%	4.8%
SA1					14			1804		404		2230	40.7%	2.3%
SA2					5			1722				1722	31.5%	1.8%
SA3					9			1118		399		1522	27.8%	1.6%
Savage					14			4644		802	0	5474	100.0%	5.7%
Land Use Total	4307	3365	15083	10467	6042	2675	1668	35071	2076	16077	0	96832		
% of Watershed Total	4.4%	3.5%	15.6%	10.8%	6.2%	2.8%	1.7%	36.2%	2.1%	16.6%	0.0%			

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NO BMPs APPLIED**Table 4.15 Total Nitrogen Loading Rates (lbs/ac/yr) by Subbasin**

Model Segment	Land Use										Subbasin w/o Pt Src	Subbasin w/ Pt Src
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
Engineer Springs	2.3		3.5		1.2	6.9	6.8	0.4		5.2	0.8	0.8
HO1					9.1			0.5		6.2	0.5	0.5
								0.5		6.8	0.5	0.5
								0.4		5.5	0.5	0.5
	2.8				1.4			0.5		6.4	0.6	0.6
	2.7				1.4			0.5		6.3	0.7	0.7
								0.4		5.6	0.4	0.4
	2.6	8.8	4.1		1.4	7.9		0.5		6.0	0.7	0.7
	3.2				1.7	9.7		0.6		7.4	0.9	0.9
Hollenbeck	2.7	8.8	4.1	9.1	1.6	8.9		0.5		6.6	0.6	0.6
JA1								0.5			0.5	0.5
	2.4				1.2		7.1	0.4			5.4	0.6
	2.5	8.3	3.9		1.3	7.4	7.4	0.4	4.2	5.7	1.0	1.0
Jamul	2.4	8.3	3.9		1.3	7.4	7.4	0.4	4.2	5.6	0.8	0.8
Lee	2.9				1.5			0.5		6.7	0.9	0.9
Lyon	3.4	11.6			1.8	10.4		0.6		7.9	1.1	1.1
OVE1		7.4	3.4	7.4	1.1	6.6	6.6	0.4	3.8	5.0	1.6	1.6
	2.1	6.9	3.2	7.0		6.2		0.4		4.7	2.4	2.4
				7.3	1.1		6.5	0.4			0.7	0.7
	2.1			7.3	1.1	6.5	6.5	0.4		4.9	1.2	1.2
	2.2		3.4			6.5		0.4		5.0	0.6	0.6
			3.5				6.8	0.4	3.9	5.2	1.8	1.8
	2.5				1.3	7.6	7.6	0.5		5.8	0.7	0.7
	1.9	6.4	3.0	6.5	1.0	5.8	5.7	0.3	3.3	4.4	2.8	2.8
	2.0	6.8	3.1	6.8	1.0	6.1	6.0	0.4	3.5	4.6	3.3	3.3
Otay Valley	2.1	6.6	3.1	6.9	1.1	6.8	6.2	0.4	3.5	4.7	1.9	1.9
PV1	2.5			3.9			7.5	0.5		5.8	0.6	0.6
				3.7			7.1	0.4		5.4	0.6	0.6
	2.5		3.9		1.3		7.4	0.4		5.6	0.6	0.6
Proctor												
SA1								0.4		5.2	0.5	0.5
								0.5			0.5	0.5
								0.5		6.4	0.7	0.7
Savage								0.5		5.8	0.5	0.5
								0.5				
Land Use Average	2.5	6.6	3.2	6.9	1.5	6.9	6.4	0.5	3.6	4.9	1.0	1.0

Table 4.16 Total Phosphorus Loads (lbs/yr) by Subbasin

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NO BMPs APPLIED

Model Segment	Land Use										Pt Src Loads	Subbasin Total	% of HSA Total	% of Watershed Total		
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS						
Engineer Springs	8.6		0.1		13.2	0.7	0.0	10.4		9.1		42.2	100.0%	0.9%		
Hollenbeck	HO1				11.3			62.4		7.6		81.3	11.1%	1.7%		
	HO2							65.7		0.7		66.4	9.1%	1.4%		
	HO3							31.9		13.2		45.0	6.2%	0.9%		
	HO4	0.0				19.8		65.2		25.3		110.4	15.1%	2.3%		
	HO5	11.0				14.5		33.2		14.6		73.3	10.0%	1.5%		
	HO6							46.4		0.3		46.7	6.4%	1.0%		
	HO7	35.7	0.3	0.4		3.3	0.9	41.9		13.6		96.2	13.2%	2.0%		
	HO8	8.8				74.7	1.3	75.1		51.4		211.4	28.9%	4.4%		
Hollenbeck	55.6	0.3	0.4	11.3	112.4	2.3		421.9		126.5	0.0	730.7	100.0%	15.4%		
Jamul	JA1							17.4				17.4	6.1%	0.4%		
	JA2	9.6				2.1		15.1				33.2	11.7%	0.7%		
	JA3	30.0	1.8	7.2		71.0	2.0	3.6	42.9			232.6	82.1%	4.9%		
	Jamul	39.6	1.8	7.2		73.1	2.0	3.8	75.4	18.3	62.0	0.0	283.1	100.0%	6.0%	
Lee	7.5					36.7			22.3			76.1	100.0%	1.6%		
Lyon	16.1	1.6				25.6	3.2		28.6			101.7	100.0%	2.1%		
Otay Valley	OVE1	0.3	54.5	23.9		0.4	1.6	5.5	19.3	24.3	92.7		222.4	7.1%	4.7%	
	OVE2	0.2	4.1	29.0	254.0		5.7		19.5		80.3		392.8	12.5%	8.3%	
	OVE3				28.9	0.2		2.0	15.5				46.6	1.5%	1.0%	
	OVE4	49.5			70.2	0.1	32.8	0.8	31.9		44.5		229.9	7.3%	4.8%	
	OVE5	2.2		5.2			11.8		27.2		9.8		56.3	1.8%	1.2%	
	OVE6			64.0				2.2	13.6	9.5	122.1		211.4	6.7%	4.4%	
	OVE7	1.3					50.9	15.7	60.5		1.0		129.5	4.1%	2.7%	
	OVW1	3.7	97.9	251.6	142.0	0.6	3.1	31.5	18.1	46.2	334.4		929.0	29.5%	19.5%	
	OVW2	2.5	68.5	336.7	55.4	0.3	24.8	19.6	8.3	44.7	371.5		932.3	29.6%	19.6%	
Otay Valley	59.2	170.9	741.0	574.3	1.7	130.8	77.3		213.9	124.8	1056.2	0.0	3150.1	100.0%	66.3%	
Proctor	PV1	2.5			14.2		14.3		9.7	81.3		8.7	130.7	78.0%	2.7%	
	PV2				2.4	0.2			2.6	17.8		13.9	36.8	22.0%	0.8%	
	Proctor	2.5		16.6		14.5			12.3	99.1		22.6	0.0	167.5	100.0%	3.5%
Savage	SA1			0.7		0.4				51.7		34.7		87.4	43.0%	1.8%
	SA2			0.3						49.3				49.3	24.3%	1.0%
	SA3			0.3		0.4				32.0		34.3		66.6	32.8%	1.4%
	Savage			0.7						133.0		69.0	0.0	203.4	100.0%	4.3%
Land Use Total	189.1	174.6	765.9	586.0	277.5	138.9	93.4	1004.6	143.0	1381.6	0.0	4754.8				
% of Watershed Total	4.0%	3.7%	16.1%	12.3%	5.8%	2.9%	2.0%	21.1%	3.0%	29.1%	0.0%					

Table 4.17 Total Phosphorus Loading Rates (lbs/ac/yr) by Subbasin

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NO BMPs APPLIED

Model Segment	Land Use										Subbasin w/o Pt Src	Subbasin w/ Pt Src
	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS		
Engineer Springs	0.10		0.18		0.05	0.36	0.38	0.01		0.45	0.03	0.03
HO1					0.51			0.01		0.53	0.02	0.02
								0.02		0.59	0.02	0.02
								0.01		0.47	0.02	0.02
	0.12					0.07		0.01		0.55	0.02	0.02
	0.12					0.07		0.01		0.54	0.03	0.03
								0.01		0.48	0.01	0.01
								0.01		0.52	0.03	0.03
	0.11	0.46	0.21		0.06	0.41		0.01		0.64	0.04	0.04
Hollenbeck	0.14	0.46	0.21	0.51	0.08	0.51		0.02		0.57	0.04	0.04
	0.12	0.46	0.21	0.51	0.07	0.46		0.01			0.02	0.02
JA1								0.01			0.01	0.01
	0.10				0.06		0.40	0.01			0.47	0.02
	0.11	0.43	0.20		0.06	0.39		0.41	0.01	0.29	0.49	0.05
	0.11	0.43	0.20		0.06	0.39		0.41	0.01	0.29	0.48	0.04
Lee	0.13				0.07				0.02		0.58	0.04
Lyon	0.15	0.60			0.08	0.54			0.02		0.68	0.05
OVE1		0.38	0.17	0.42	0.05	0.34		0.37	0.01	0.26	0.43	0.09
	0.09	0.36	0.16	0.39		0.32			0.01		0.41	0.14
			0.41		0.05			0.36	0.01			0.03
	0.09			0.41	0.05	0.34		0.36	0.01		0.42	0.06
	0.10		0.17			0.34			0.01		0.43	0.02
		0.18						0.38	0.01	0.27	0.45	0.12
								0.43	0.01		0.50	0.03
	0.11		0.15	0.36	0.06	0.40			0.01		0.38	0.03
	0.08	0.33			0.05	0.30		0.32	0.01	0.23	0.38	0.17
OVW1	0.09	0.35	0.16	0.38	0.05	0.31		0.34	0.01	0.24	0.40	0.20
	0.09	0.34	0.16	0.39	0.05	0.35		0.35	0.01	0.24	0.40	0.11
Otay Valley	PV1		0.20		0.06		0.42		0.01		0.50	0.02
	PV2		0.19		0.06		0.40		0.01		0.47	0.02
	0.11		0.20		0.06		0.42	0.01			0.48	0.02
SA1			0.18		0.05			0.01			0.45	0.02
			0.53					0.01			0.01	0.01
			0.53		0.05			0.01			0.55	0.03
Savage			0.18		0.05			0.01			0.50	0.02
			0.53					0.01			0.02	0.02
			0.53					0.01			0.50	0.02
Land Use Average	0.11	0.34	0.16	0.39	0.07	0.36	0.36	0.01	0.24	0.42	0.05	0.05

SECTION 5.0

BMP REPRESENTATION AND OPERATION

AQUA TERRA Consultants (ATC) developed the OWPL Tool as an Excel workbook to perform constituent loading calculations, based on the PLOAD methodology, for a variety of constituents in the Otay Watershed. This section discusses the incorporation of the capability to represent BMP impacts on watershed loadings, which is an option in PLOAD.

BMP capabilities were incorporated into the calculations consistent with the PLOAD methodology, and were designed to be implemented within the constraints of a spreadsheet application. As noted in Section 2, BMP impacts are calculated as a reduction in the raw pollutant loads determined in a previous operation of the workbook. The effects of BMPs on those loads are calculated for each land use and BMP according to the following equation:

$$L_{BMP} = L_P - [L_P * AS_{BMP} * (\%EFF_{BMP}/100)]$$

Where:

L_{BMP} = BMP-reduced load, lbs/yr

L_P = Raw pollutant load, lbs/yr

AS_{BMP} = Fraction of area serviced by the BMP

$\%EFF$ = Percent load reduction of BMP

To perform a new set of calculations that represents a BMP scenario, the user follows these steps:

- 1) Make a copy of the original workbook and rename it with a title that describes the BMP scenario
- 2) Open the workbook and edit the I_BMP sheet (discussed below) to include the desired BMPs and needed information. Each BMP has its own separate Removal Efficiency factors, and an Application Area table is used to define where each BMP is applied; templates for these two tables are shown in Table 5.1. The user must provide the following information:
 - a. Name/type of BMP
 - b. Subbasin where it is located
 - c. Areas of each land use that it services
 - d. Removal efficiencies for each WQ constituent
- 3) Execute the “PLoadRun” macro either by selecting Tools-Macro-Macros-PLoadRun from the main menu or by typing ‘control-p’
- 4) Save the workbook under its new name
- 5) Compare the Raw loads to the BMP-reduced loads in order to show the BMP impacts. This can be done by comparing the two load tables generated by the Tool. Note that the output spreadsheets identify when a run is performed with BMPs by including the phrase ‘**BMPs APPLIED**’ shown in red in the upper right corner of the spreadsheet.

The OWPL Tool allows specification of up to 10 different BMPs within a single operation of the workbook. In addition, multiple BMPs can be applied to the same land use within the same subbasin, and their effects will be cumulative. However, not more than 100% of the land use category will be treated. That is, the tool does not allow multiple BMPs to be applied to the same parcel of land. To

represent that condition the user must separately calculate the combined Removal Efficiency of all the BMPs and their application areas, and then represent that as a single effective BMP within the Tool.

Table 5.1 Sample Template for the I_BMP Spreadsheet of the OWPL Tool

BMP Name	Detention Barir	Agricultural Practices								
Constituent	Removal Efficiency (%)									
BOD_5	10	20								
TSS	30	50								
TDS	60	40								
NO23-N	20	30								
NH3-N	20	30								
TKN	15	30								
TN	15	30								
PO4-P	20	30								
TP	15	30								
T_CU	40	10								
T_ZN	30	10								
T_PB	40	10								
OIL_GREASE	60	0								
FEC_COLI	10	50								
FLOW	10	50								

Area Table												
Application Area by Subbarin	BMP Applied	AG	COM	HD_RES	IND	LD_RES	PUB_FAC	PUB_UTIL	REC/OPEN	SCHOOL	TRANS	TOTAL AREA
ES1	2	43.4										43.4
H01	1					11.2						7.2
H02	1											0.6
H03	1											2135.7
H04	1	0.1										1294.4
H04	2	0.1										2259.1
H05	1	45.9										1169.6
H06	1											1834.4
H07	1	155.8	0.3	0.9			26.7	1.1				1547.4
H07	2	155.8										155.8
H08	1	31.2										31.2
H08	2	31.2										31.2
JA1	2											0.0
JA2	2	46.4										46.4
JA3	2	138.9										138.9
LE1	2	29.1										29.1
LY1	2	53.4										53.4
OVE1	1		0.4	156.8	28.7	3.5	2.3	7.4	851.3	47.0	107.1	1204.6
OVE2	1		0.9	5.7	88.6	324.7		8.9	910.6			98.6
OVE3	1					35.4	2.1		695.3			735.5
OVE4	1		262.5			86.1	1.2	48.8	1.1	1432.4		52.5
OVE5	1		11.4		15.2			17.3		1210.4		11.5
OVE6	1				177.8					2.9	576.2	17.7
OVE7	1		5.9					1.2	64.2	18.5	2306.5	1.0
OWW1	1	21.9	146.9	832.0	196.4	6.3	5.3	49.1	915.3	102.3	444.1	2719.6
OWW2	1	13.9	97.6	1057.3	72.7	3.2	39.4	29.1	399.2	94.1	468.4	2274.9
PV1	1	11.3			35.7		119.6			11.5	3128.7	8.8
PV2	1				6.3		1.5			3.3	722.9	14.8
SA1	1				1.9		3.6				2187.2	38.5
SA2	1										1744.9	2231.2
SA3	1					0.3					1102.5	31.0
	Total:	1059.2	250.9	2372.5	755.6	1063.2	188.6	125.7	35174.7	261.0	1547.2	42798.6

SECTION 6.0

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